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A Survey of Polybrominated Biphenyls (PBBs) Near Sites of Manufacture and Use in Northeastern New Jersey

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A SURVEY OF POLYBROMINATED BIPHENYLS (PBBs) NEAR SITES OF MANUFACTURE AND USE IN NORTHEASTERN NEW JERSEY

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1.0 INTRODUCTION

Polybrominated biphenyls (PBBs) are a class of chemical compounds with a chemical structure as follows:

where X can be any number from 0 to 5. These compounds were first produced in the United States in commercial quantities in 1970. The compounds have been used as flame retardants for plastics, textiles, and other materials.

Firemaster BP-6® is the trade name (Michigan Chemical Corporation) for a commercially produced PBB mixture containing approximately 75 percent bromine by weight (Mumma and Wallace, 1975). The predominant PBB isomer in this commercial mixture is hexabromobiphenyl ($C_{12}H_4Br_6$), which constitutes approximately 62.8 percent of the total PBB content. The Firemaster BP-6 product also contains approximately 2.0 percent tetrabromobiphenyl ($C_{12}H_6Br_4$), 10.6 percent pentabromobiphenyl ($C_{12}H_5Br_5$), 13.8 percent heptabromobiphenyl ($C_{12}H_3Br_7$), and 11.4 percent other brominated biphenyl isomers, principally octabromobiphenyl ($C_{12}H_2Br_8$), nonabromobiphenyls ($C_{12}HBr_9$), and decabromobiphenyl ($C_{12}Br_{10}$). In addition to Firemaster BP-6, octabromobiphenyl and decabromobiphenyl have also been produced in commercial quantities. Monobromobiphenyl ($C_{12}H_{11}Br$) and dibromobiphenyl ($C_{12}H_{10}Br_2$) have been produced in the United States in laboratory or kilogram quantities for research purposes.

An ecological survey was conducted to determine the presence of polybrominated biphenyls (PBBs) in the environment near three industrial sites. The sites chosen for the survey were:

a) White Chemical Corporation
   Bayonne Industrial Park
   Bayonne, New Jersey

b) Marcor, Inc.
   Standard T Chemical Company, Inc., Subsidiary
   Staten Island, New York

c) Hexcel Corporation
   Fine Organics Division
   Sayreville, New Jersey

The locations of these three industries to the north and southwest of Staten Island are shown in Figure 1-1.

White Chemical Corporation produced an estimated total of 45,350 kilograms of octabromobiphenyl and decabromobiphenyl at the facility in Bayonne, New Jersey during the period 1970 to 1973 (Mumma and Wallace, 1975). Production was discontinued in 1973. The amount produced constitutes about 4 percent of the total amount of PBB produced in the United States.

Standard T Chemical Company on Staten Island, New York was one of two major domestic users of Firemaster BP-6. The product was blended into various plastic resins, principally ABS (acrylonitrile-butadiene-styrene) resins, to produce flame-retardant plastics.

Hexcel Corporation, Fine Organics Division in Sayreville, New Jersey is reported (EPA, 1977) to be a producer of laboratory quantities of various PBBs.

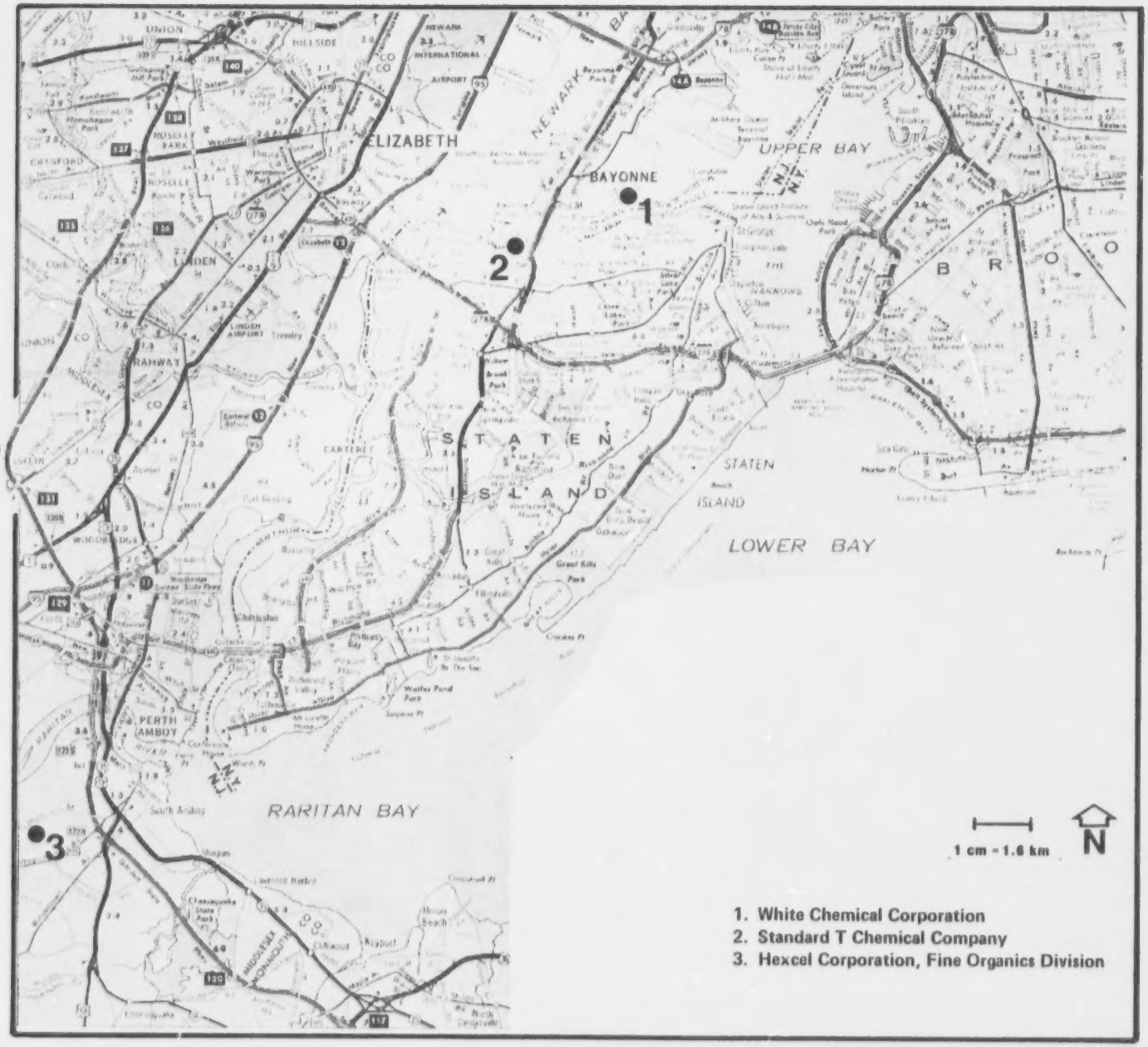

Figure 1-1. LOCATION OF THE THREE INDUSTRIES SAMPLED

Sample collection occurred during the period April 11-16, 1977 near each of the three industries. Samples were taken of air, soil, water, wastewater, bottom sediments, and available biota. Human hair samples were also collected at barbershops and beauty parlors in nearby communities. A total of 340 samples were collected during the survey. Forty-eight samples were selected for analysis of PBB by gas chromatography/mass spectroscopy (GC/MS).

2.0 SUMMARY AND CONCLUSIONS

Environmental contamination with PBBs was detected at all three sites chosen for this survey. The highest levels of PBBs detected were 9.8 ug/l in waters, 60 ppb in aquatic sediments, 4.6 ppm in soils, 230 ppb in fish tissue, 92 ppm accumulated on marsh vegetation, and 431 ppm in a sludge deposit. Air samples contained traces of hexabromobiphenyl. Human hair samples contained up to 310 ppm of PBB in extractable oil. There is conclusive evidence of either past or ongoing wastewater-borne discharge of PBBs at all three locations and indirect evidence of airborne discharges of PBBs at White Chemical Corporation and Standard T Chemical Company. The presence of PBBs in human hair oils is an indication of possible human exposure to this class of substances in the areas surveyed.

2.1 WHITE CHEMICAL CORPORATION

At White Chemical Corporation in Bayonne, New Jersey a primary industrial wastewater treatment basin (the Platti Kill) has apparently received PBB contaminated wastewater. Sludge accumulations in the basin contained up to 431 ppm PBB including all isomers, except tetrabromobiphenyl, but predominately nonabromobiphenyl (22.5 ppm) and decabromobiphenyl (390 ppm). Octabromobiphenyl, which was reported to have been manufactured by White Chemical Corporation along with decabromobiphenyl, was present, but in a substantially lower concentration (3.6 ppm). Numerous other brominated organic chemical compounds, including bromobenzenes, bromotoluene, and bromodiphenyl ethers, were also present. White Chemical Corporation manufactures bromodiphenyl ethers.

The data indicate that wastewaters leaving the treatment basin carry PBBs into nearby ambient waters. The absence of PBBs in bottom sediments near the discharge from the treatment basin, however, may indicate PBBs are either chemically or biologically degraded in anaerobic bottom sediments. The maximum sediment concentration of PBBs measured in the vicinity was 20 ppb near the discharge of a sewage treatment plant serving the area--and only hexa- and heptabromobiphenyl were detected at this point.

Fish captured in the vicinity of White Chemical Corporation contained 220 ppb of PBB. Bioaccumulation of these substances has apparently occurred in aquatic organisms in the area. Only the nonabromobiphenyl and hexabromobiphenyl isomers were present, however, so either metabolism or selective bioaccumulation of PBBs is taking place. If decabromobiphenyl, which is the predominant isomer discharged, is bioaccumulated by the fish, then the decabromobiphenyl must be subsequently eliminated, biodegraded, or possibly debrominated to nona- or hexabromobiphenyl within the fish tissue. Hepta- and octabromobiphenyl apparently undergo a similar fate, for they too are absent in the fish tissue. Algae collected in the vicinity did not contain PBBs, so there is no evidence of accumulation in plant tissue.

Although an air sample taken downwind of the White Chemical Corporation facility contained traces of hexabromobiphenyl, a sample taken during crosswind conditions did also. Hence, there is no direct evidence of

airborne discharge of PBBs, however, there is apparently either an indirect or a direct source in the general area.

If airborne discharges occur or have occurred over a lengthy period of time, accumulations of PBBs may be expected in soils near the facility. In fact, soil concentrations of 4.2 ppm were detected in the prevailing downwind direction and 1.1 ppm in the prevailing upwind direction. The soil in the prevailing downwind direction (to the east) contained, in addition to the higher concentration, the higher relative amount of the least volatile nona- and decabromobiphenyls. The soil in the predominant upwind direction contained greater relative amounts of the more volatile hepta- and octabromobiphenyls. Vegetation in the area may also be expected to accumulate airborne discharged PBBs in trapped dustfall. A lichen taken near the facility had accumulated 1.3 ppm of PBBs. The isomeric composition of this accumulated dust was similar to that of the contamination in the prevailing downwind soil sample.

2.2 STANDARD T CHEMICAL COMPANY

There is some evidence of waterborne discharges of PBBs into Kill van Kull at Standard T Chemical Company located on Staten Island. Sediments near an outfall contained the relatively low concentration of 60 ppb hexa- and heptabromobiphenyls. Again, the relatively low bottom sediment concentration near the outfall may indicate PBB instability in anaerobic sediments. Fish taken near the discharge contained 230 ppb of PBB. This is very similar to the concentration (220 ppb) measured in fish taken in the vicinity of White Chemical Corporation, however, the

isomeric composition of the PBB is different. At the former location the contamination consisted of 82 percent nonabromobiphenyl and 18 percent hexabromobiphenyl. At this location, only hexabromobiphenyl was detected. This may reflect the fact that White Chemical Corporation has manufactured the more highly-substituted isomers, while Standard T Chemical Company is a major user of Firemaster BP-6, which is predominately hexabromobiphenyl. Algae, again, did not contain PBBs.

There is indirect evidence of airborne discharge of PBBs in the vicinity of Standard T Chemical Company. A trace of hexabromobiphenyl was detected in a downwind air sample. Additional air samples have not been analyzed, however, so this is certainly insubstantial direct evidence of airborne discharge. Soil accumulations of PBBs have, however, been detected in the vicinity. The highest soil concentration (100 ppb) 700 meters from the facility in the prevailing downwind direction consisted entirely of pentabromobiphenyl. This isomer constitutes approximately 10.6 percent of Firemaster BP-6. Soil samples taken at closer (75 meters) and more distant locations (1,500 meters) from the facility in prevailing upwind and crosswind directions contained 10 to 30 ppb of PBBs. In these samples, hexabromobiphenyl was the dominant isomer. Selective airborne transport of the various isomers is indicated, however, there is inadequate data to more clearly define the nature of airborne transport.

2.3 HEXCEL FINE ORGANICS DIVISION

Residue in receiving waters, storm sewer waters, marsh soils, and on wetland vegetation indicates there have been waterborne discharges of PBBs in the vicinity of Hexcel Fine Organics Division near Sayreville, New Jersey. The discharge has entered a swampy depression where reeds have accumulated surface concentrations of 92 ppm and waters contain up to 210 ug/l. Decabromobiphenyl is in greatest evidence. Contaminated waters (138 ug/l) were also discovered in the local storm sewer system, indicating the discharge of decabromobiphenyl-contaminated wastewaters to this system has occurred. There is no evidence of airborne PBB discharges at this location.

2.4 HUMAN HAIR ANALYSIS

Certain human hair samples collected from barbershops and beauty parlors located in the community nearest all three sites contained PBBs. Of the nine samples analyzed, five contained detectable PBB levels.

Near White Chemical Corporation, one sample contained 8.1 ppm of dibromobiphenyl in the extracted oils. Two other samples were PBB-free. All three hair samples taken from the community near Standard T Chemical Company contained PBBs. The highest level was 26 ppm in extracted oils. This sample contained hexa-, hepta-, octa-, nona- and decabromobiphenyl, with the latter constituting 77 percent of the total. The other two samples (740 ppb and 440 ppb) contained only hexabromobiphenyl.

One hair sample taken in Sayreville contained a total of 310 ppm of PBBs consisting of hexa-, nona-, and decabromobiphenyls, with the latter constituting 92 percent of the total. Two other samples did not contain detectable levels of PBB.

As a result of limited knowledge of the exact origin of the hair that was collected, only very general conclusions can be reached. These data are, however, evidence of human exposure to PBBs. Since no data exists for other locations, it is difficult to ascertain whether the exposure is related to the workplace or to the ambient environment. A more extensive and definitive sampling program would be necessary. The large difference in concentrations for various samples, from undetected levels (<100 ppb) to 310 ppm in extracted oils, seems to indicate only selected individuals have been exposed. Both male and female hair samples contained PBBs.

There are identifiable differences in the isomeric composition of the PBBs found on hair from the three locations. The samples with the highest concentrations contained relatively large amounts of the decabromobiphenyls, while the samples with lower concentrations contained only hexabromobiphenyl. The sample containing dibromobiphenyl was characteristically much different from the other four samples containing PBBs. Dibromobiphenyl was not detected in any other media. It could, perhaps, be a metabolite of a previous PBB exposure.

The survey reported in this document has demonstrated that PBBs have entered the environment in the vicinity of PBB manufacturers and users in the Northeast New Jersey and Southern New York area. Contamination of surface waters, bottom sediments, soils, vegetation, and aquatic organisms is evident. Airborne discharge is implied but not proven by the data. Human exposure is indicated by results for human hair samples.

3.0 SAMPLING PROGRAM

3.1 SAMPLE COLLECTION AND PREPARATION

Sample collection occurred during the period April 11-17, 1977 near each of the three industries. Samples were taken of air, soil, water, wastewater, bottom sediments, and available biota. Human hair samples were also collected at barbershops and beauty parlors in nearby communities. A total of 340 samples were collected during the survey. Forty-eight samples were selected for analysis of PBB by gas chromatography/mass spectroscopy (GC/MS). Appendix A is a tabulation of all the samples taken at each site. Those samples that have not been analyzed have been retained in cold storage or frozen for future disposition.

Air

Air samples were 6 to 24-hour, high-volume samples using porous polyurethane foam as the collection medium. The sampling apparatus is depicted in Figure 3-1. Polyurethane foam plugs were cut from a 7.6 cm sheet to fit snugly into the throat of the sampling apparatus. These foam plugs were pre-extracted with toluene at 100°C to remove any contaminants before sample collection. Collection efficiency studies, using the apparatus shown in Figure 3-1, have not been conducted for PBBs. Hence, the reported airborne PBB concentrations must be considered to be minima. A high-collection efficiency using this high-volume sampling apparatus has been demonstrated for polychlorinated biphenyls (PCBs) by Stratton, Whitlock, and Allan (1977).

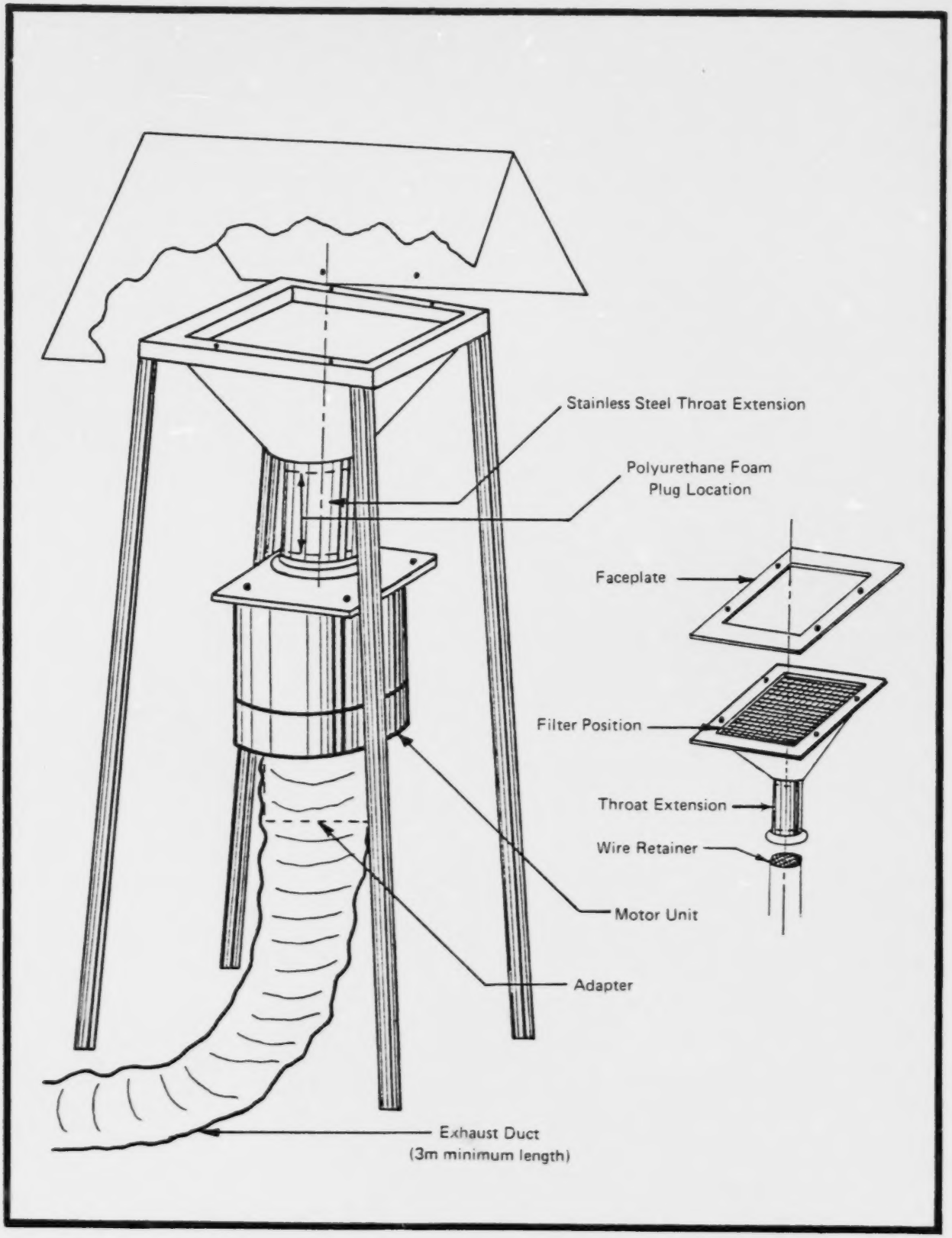

FIGURE 3-1. ASSEMBLED SAMPLE AND SHELTER WITH EXPLODED VIEW OF THE FILTER HOLDER.

The polyurethane foam plugs were exposed to the ambient air by drawing air through the material located in the throat of the sampler at the rate of approximately 1.0 m^3/min. The flow rate is measured at the beginning and end of the sample collection period and the average total flow is computed. Detailed sampling procedures have been described by Stratton, Whitlock, and Allan (1977).

Upon return to the laboratory, the polyurethane foam plugs and the glass-fiber filters were extracted with hexane in the soxhlet extraction apparatus. The hexane was concentrated on a Kuderna-Danish evaporator concentrator to 1.0 ml and subjected to GC/MS analysis.

Soil

Each soil sample is constituted of an homogenized composite of five sub-samples taken within a 10-meter radius to a depth of 2.5 cm at the location described in the data tables. This composite sampling technique is illustrated in Figure 3-2. Sample points were chosen that were essentially free of vegetation and where excessive wind erosion was not apparent.

Soil samples were extracted with hexane in a soxhlet apparatus. The extract was concentrated to 1.0 ml on a Kuderna-Danish evaporator, cleaned up on a florisil chromatographic column, and packaged in hermetically sealed vials prior to GC/MS analysis.

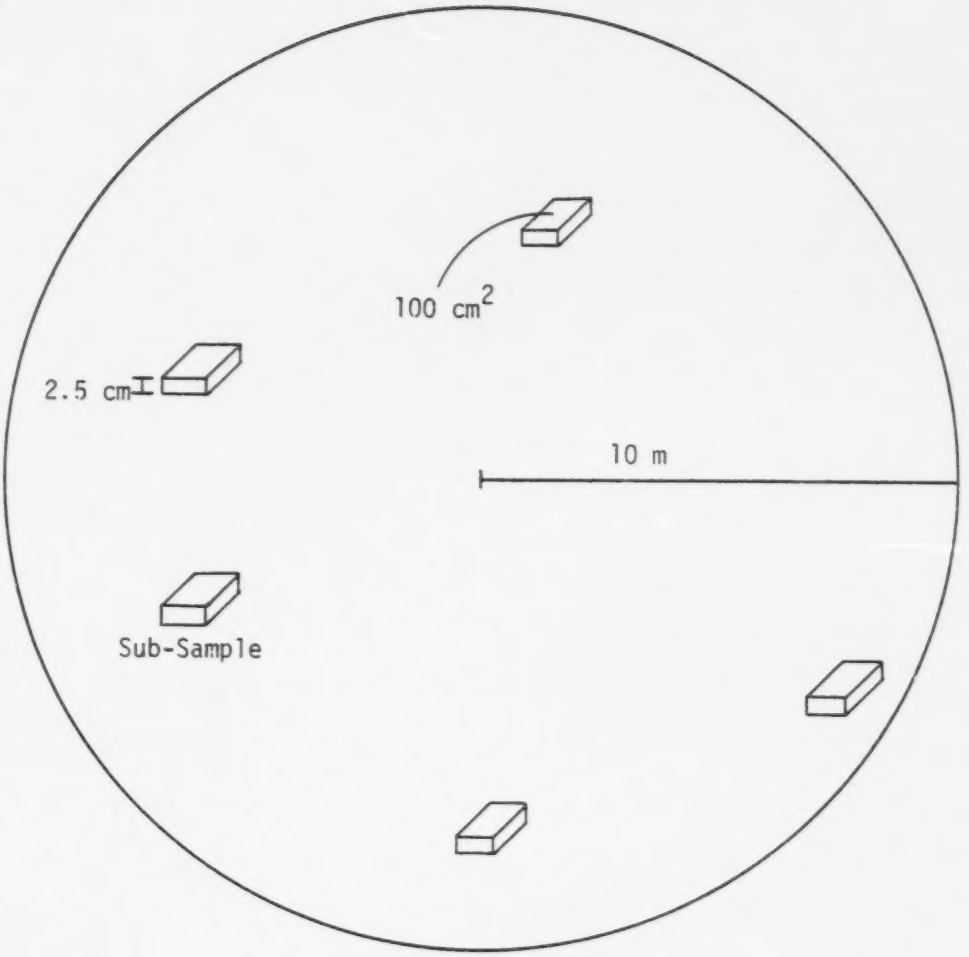

FIGURE 3-2. DIAGRAM SHOWING SURFACE SOIL SAMPLING METHOD.

Not to scale. Five sub-samples are composited to yield a single sample.

Water and Wastewater

Grab samples of ambient waters were taken just below the surface and, in addition for deeper waters, at mid-depth and one-half meter above the bottom. The deeper samples were taken with a Van Dorn sampler. Wastewaters were collected directly from the outfall or retention basin as appropriate to the site. All samples were placed in solvent-rinsed glass containers.

Each one-liter water sample was extracted three times with hexane in a separatory funnel using the procedures described by the EPA (1974) for PCB in waters. The hexane extract was concentrated to 1.0 ml, and cleaned-up with florisil before GC/MS analysis.

Bottom Sediments

A Ponar dredge sampler was used to collect bottom sediments and sludges. These samples were taken after the overlying water sampling was complete in order to avoid atypical suspension of sediments in the water column. Sediment samples were placed in solvent-rinsed glass containers.

Sediment and sludge samples were extracted with hexane in a soxhlet apparatus, and the extract cleaned-up in the same manner as described above for soils. The moisture content was determined on a separate fraction of the homogenized sample.

Biological Tissue

Samples of plant and animal biota were collected as available. Fish were collected using an otter trawl and algae with a plankton net. All samples were placed in sealed, solvent-rinsed glass containers and chilled. Animal tissue was frozen shortly after collection.

Terrestrial vegetation (i.e., reeds, lichen) was analyzed for PBB by rinsing a measured quantity with hexane in a beaker. The hexane was subsequently concentrated on a Kuderna-Danish evaporator concentrator to 1.0 ml and subjected directly to GC/MS analysis. The resulting analytical data was calculated as mass of PBB accumulated on a unit mass of vegetation.

Animal tissue and algae were hard frozen. To a measured quantity of crushed, frozen tissue was added 5 g of clean, sharp sand and 5 g of anhydrous sodium sulfate (Na_2SO_4). Whole fish were used, since those analyzed were very small in size. The tissue was then ground to obtain a uniform, dry granular mass. This material was extracted with hexane in a soxhlet extraction apparatus. The hexane extract was concentrated to 0.5 ml on a Kuderna-Danish apparatus and passed through a florisil chromatographic column using the procedures of Fehringer (1975) and EPA (1974). The eluate was concentrated to 1.0 ml and placed in a hermetically sealed vial prior to GC/MS analysis. Moisture content of the tissue was determined on a separate fraction of the homogenate. Analytical results are reported on a dry weight basis.

Human Hair

The human hair samples were extracted with hexane and evaporated to determine the quantity of oil per unit mass of hair (g/g). The oil was then redissolved in hexane, passed through a florosil column to remove lipids, collected and analyzed for PBB. These procedures are described by Domanski and Guthrie (1976). The analytical results are reported as ppb in the extracted oil. The oil content ranged from 1.0 to 1.4 percent of the hair.

3.2 SAMPLE ANALYSIS

To each sample extract an internal standard of octachloronaphthalene was added before sealing in a septum-topped vial. The extracts were stored at 4°C in the dark until shipment to Research Triangle Institute (RTI) for GC/MS analysis. The sample extracts were shipped to RTI on ice by air courier. GC/MS analytical methods and the analytical results are described by Erikson, Zweidinger, and Pellizzari (1977). The multiple ion detection mode of analysis was used for all samples. PBB was confirmed in several of the samples by full mass spectrum comparison with authentic PBB standards.

4.0 RESULTS AND DISCUSSION

4.1 WHITE CHEMICAL CORPORATION

Table 4-1 is a summary of the analytical results for samples collected in the vicinity of the White Chemical Corporation manufacturing facility in the Bayonne Industrial Park, Bayonne, New Jersey. Figure 4-1 is a site diagram taken from a topographic map of the area showing the location of the samples reported in Table 4-1. The facility is located along the waterfront as shown in Figure 1-1.

The Platti Kill is a dead-end canal directed northward off Kill van Kull. This canal penetrates the center of the Bayonne Industrial Park approximately 450 meters to the east of the plant site (see Figure 4-1). The head of the Platti Kill, which is located approximately 540 meters from Kill van Kull, is used as a primary wastewater treatment basin by a number of industries in the area, including White Chemical Corporation. Two booms have been placed across the head of the Platti Kill to impede passage of oils and surface scum down the canal and into Kill van Kull. Between the two surface booms, a dike has been placed across the canal to impede sludge and sediment transport. At the time of sampling, a wastewater flow of approximately 10,200 liters per minute (2,700 gal/min) was discharging from a 0.6-meter diameter outfall into the diked basin. Heavy oil and grease accumulations were present on the surface.

A water sample taken at a depth of one-third meter below the surface scum in the wastewater treatment zone at the head of the Platti Kill (sample 13W) contained 46 ug/l PBB. The isomeric composition of the PBB

Table 4-1. Analytical Results for Samples Taken in the Vicinity of White Chemical Corporation, Bayonne, New Jersey*

Sample Number	PBB ISOMER $C_{12}H_9Br$ 1	$C_{12}H_8Br_2$ 2	$C_{12}H_7Br_3$ 3	$C_{12}H_6Br_4$ 4	$C_{12}H_5Br_5$ 5	$C_{12}H_4Br_6$ 6	$C_{12}H_3Br_7$ 7	$C_{12}H_2Br_8$ 8	$C_{12}HBr_9$ 9	$C_{12}Br_{10}$ 10	Total†	Comments
10S	<10	<10	<10	<10	<10	30	30	90	2,000	2,100	4,250	Soil
11S	<10	<10	<10	<10	<10	15	110	150	330	530	1,135	Soil
12W	<0.2	<0.2	<0.2	<0.2	<0.2	0.2	0.2	1.7	2.0	5.7	9.8	Water at mouth of Platti Kill
13W	<0.2	<0.2	<0.2	<0.2	0.5	1.5	1.1	1.1	7.1	35	46	Water at head of Platti Kill
14W	--	--	--	--	--	--	--	--	--	--	ND	Water at mouth of Platti Kill
15A	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	0.06	Crosswind Air 4/12-4/13/77
16A	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	0.06	Downwind Air 4/11-4/12/77
17SE	540	2,200	4,300	<10	590	3,800	3,300	3,600	22,500	390,000	431,000	Sludge at Head of Platti Kill
18SE	--	--	--	--	--	<10	<10	<10	<10	<10	<10	Sediment at Mouth of Platti Kill
19SE	--	--	--	--	--	<10	<10	<10	<10	<10	<10	Sediment in Kill van Kull
20SE	<10	<10	<10	<10	<10	10	10	<10	<10	<10	20	Sediment, Port Johnson
21T	--	--	--	--	--	<10	<10	<10	<10	<10	<10	Algae, Port Johnson
22T	<10	<10	<10	<10	<10	50	50	50	420	700	1,270	Lichen
23T	<10	<10	<10	<10	<10	40	<10	<10	180	<10	220	Killifish

Table 4-1. Analytical Results for Samples Taken in the Vicinity of White Chemical Corporation, Bayonne, New Jersey (cont'd)

Sample Number	PBB ISOMER $C_{12}H_9Br$ 1	$C_{12}H_8Br_2$ 2	$C_{12}H_7Br_3$ 3	$C_{12}H_6Br_4$ 4	$C_{12}H_5Br_5$ 5	$C_{12}H_4Br_6$ 6	$C_{12}H_3Br_7$ 7	$C_{12}H_2Br_8$ 8	$C_{12}HBr_9$ 9	$C_{12}Br_{10}$ 10	Total†	Comments
39H	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	Male & Female Hair Reported as ppb in Oil
40H	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	Female Hair Reported as ppb in Oil
41H	<100	8,100	<100	<100	<100	<100	<100	<100	<100	<100	8,100	Male & Female Hair Reported as ppb in Oil

* All data reported as parts per billion (ppb), or ug/l, except for the air samples 15A and 16A which are reported as nanograms per cubic meter of air. Soil and tissue samples are reported on a dry weight basis.

ND= not detected (--).

† Sum of detected isomers in parts per billion (ppb), or ug/l, except air samples which are reported as ng/m^3.

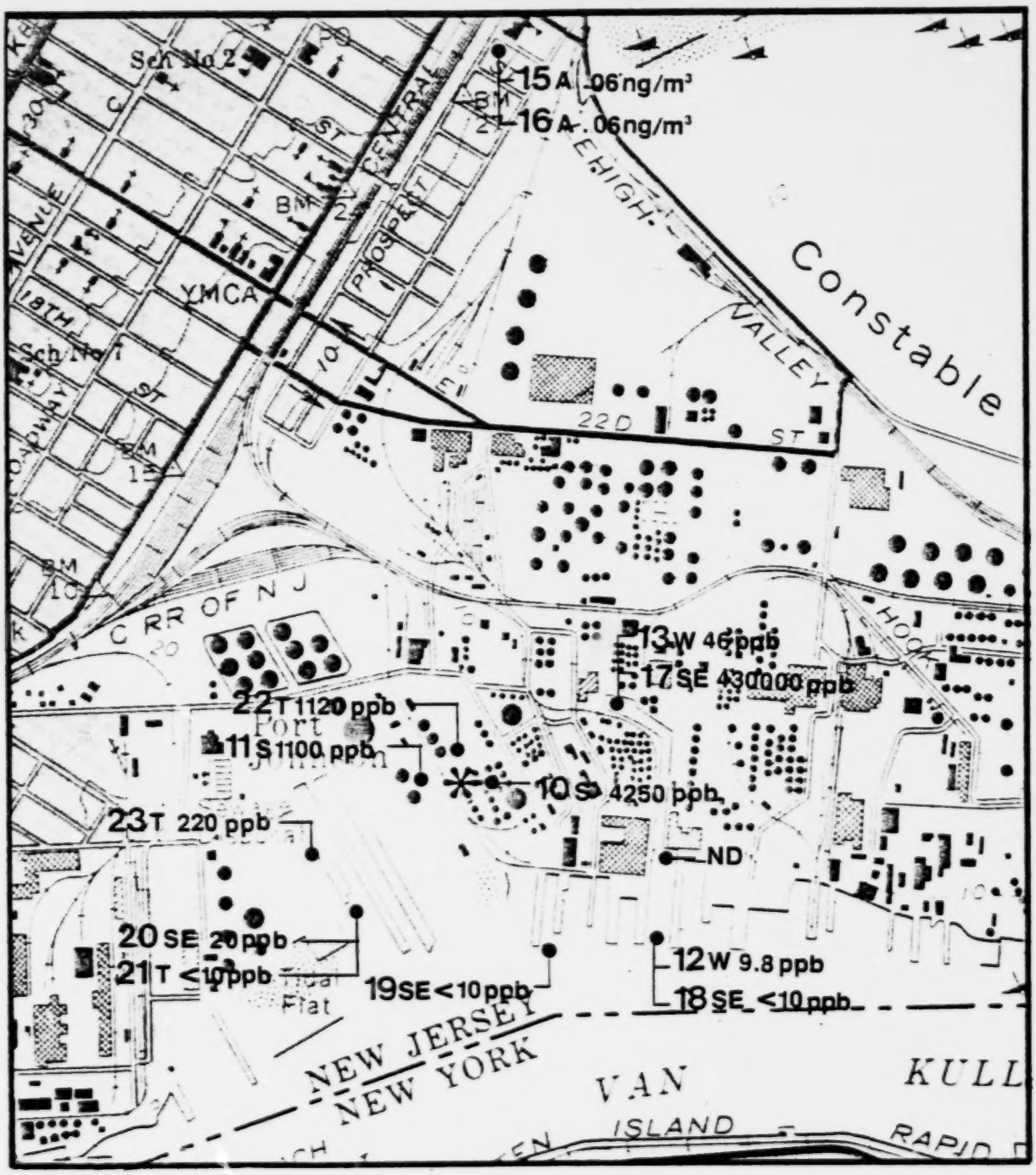

FIGURE 4-1. VICINITY OF WHITE CHEMICAL CORPORATION, BAYONNE, NEW JERSEY

* PLANT SITE

N

1 cm = 120 meters

in this water sample and other samples taken in the vicinity are summarized in Table 4-2. Decabromobiphenyl constituted 76 percent and nonabromobiphenyl 15 percent, of the total PBB detected in the wastewater. A water sample taken halfway up the Platti Kill (14W) did not contain detectable PBB, but a sample taken at the mouth (12W) contained 9.8 ug/l. As shown in Table 4-2, this sample consisted of a relatively smaller proportion of decabromobiphenyl than the sample taken in the treatment zone, but relatively larger proportions of octa- and nonabromobiphenyl.

A sample of the sludge (17SE) which has accumulated in the treatment zone at the head of Platti Kill contained 431 ppm (mg/kg) of PBB on a dry weight basis. This sample contained 90 percent decabromobiphenyl and 5 percent nonabromobiphenyl with lesser, but detectable amounts of all other PBB isomers, except tetrabromobiphenyl. Surprisingly, PBB was not detected in a bottom sediment sample (18SE) taken at the mouth of Platti Kill or in a sample (19SE) taken near the docks in the area.

GC/MS analysis of the sludge (17SE) deposit in the treatment zone at the head of Platti Kill confirmed the presence of those compounds listed in Table 4-3. PBBs were confirmed by full mass spectrum comparison with authentic PBB standards. Also present are bromobenzenes, bromotoluenes, bromoethylene, and bromodiphenyl ethers.

It appears from these data that there is presently, or has been in the past, a discharge of the higher-substituted PBBs and other brominated

Table 4-2. Percent Isomeric Composition of PBBs Detected in Samples Taken in the Vicinity of White Chemical Corporation

Sample Number	PBB ISOMER						Description
	$C_{12}H_5Br_5$	$C_{12}H_4Br_6$	$C_{12}H_3Br_7$	$C_{12}H_2Br_8$	$C_{12}HBr_9$	$C_{12}Br_{10}$	
13W	1	4	2	2	15	76	Water in treatment zone of Platti Kill
12W	0	2	2	17	20	58	Water at mouth of Platti Kill
17SE	0.1	1	1	1	5	90	Sludge in treatment zone of Platti Kill
10S	0	1	1	2	47	49	Soil 150 m east of plant
11S	0	1	10	13	29	47	Soil 150 m west of plant
20SE	0	50	50	0	0	0	Sediment at Port Johnson
22T	0	4	4	4	33	55	Lichen
23T	0	18	0	0	82	0	Fish

Table 4-3. Brominated Compounds Detected in Sludge Samples Taken From Head of Platti Kill, GC/MS Analysis

$C_6H_4Br_2$
C_2Br_4
$C_7H_5Br_3$
$C_6H_2Br_4$
$C_{12}H_7Br_3$
$C_7H_3Br_5$
C_6Br_6
$C_{12}H_6Br_4$
$C_{12}H_6Br_4O$
$C_{12}H_5Br_5$
$C_{12}H_5Br_5O$
$C_{12}H_4Br_6$
$C_{12}H_4Br_6O$
$C_{12}H_3Br_7$
$C_{12}H_3Br_7O$
$C_{12}H_2Br_8$
$C_{12}H_2Br_8O$
$C_{12}HBr_9$
$C_{12}HBr_9O$
$C_{12}Br_{10}$
$C_{12}Br_{10}O$

[a] The bromobiphenyls were confirmed by comparison of mass spectra and retention times with authentic standards.

[b] GC conditions: 2% OV-101 coated on Gas-Chrom Q; column: 45 cm x 0.2 cm i.d., 20 cc/min helium, 100° initial, programmed at 12°/min to 300°.

organic compounds into the Platti Kill. Some of the PBB is carried from the treatment zone in the water. This may be dissolved in the water, particulate adsorbed, or dissolved in oils which are in turn carried out by the water. The large predominance of decabromobiphenyl and nonabromobiphenyl in the accumulated sludge would indicate selective transport of the lesser-substituted isomers from the Platti Kill has taken place.

A bottom sediment sample (20SE) taken near a sewage treatment plant discharge at Port Johnson contained 10 ppb hexabromobiphenyl, plus 10 ppb heptabromobiphenyl. A filamentous green algae taken in the same location (21T) did not contain detectable PBB, however, killifish (23T) contained 220 ppb, consisting of 82 percent nonabromobiphenyl and 18 percent hexabromobiphenyl.

The average annual wind direction in the New Jersey/New York area is illustrated by Figure 4-2. Winds predominate from a westerly direction. During the sampling period of this survey, winds were blowing from the south on April 11-12, 1977 at approximately 5 mph. A 24-hour high-volume air sample (16A) taken downwind of White Chemical Corporation and the Platti Kill at this time contained traces of hexabromobiphenyl (0.06 ug/m^3). A sample (15A) taken at the same location with winds blowing from the west at 5-13 mph on April 12-13, 1977 yielded the same analytical results. The White Chemical Corporation facility appears to have several low velocity rooftop vents, but no emission stack.

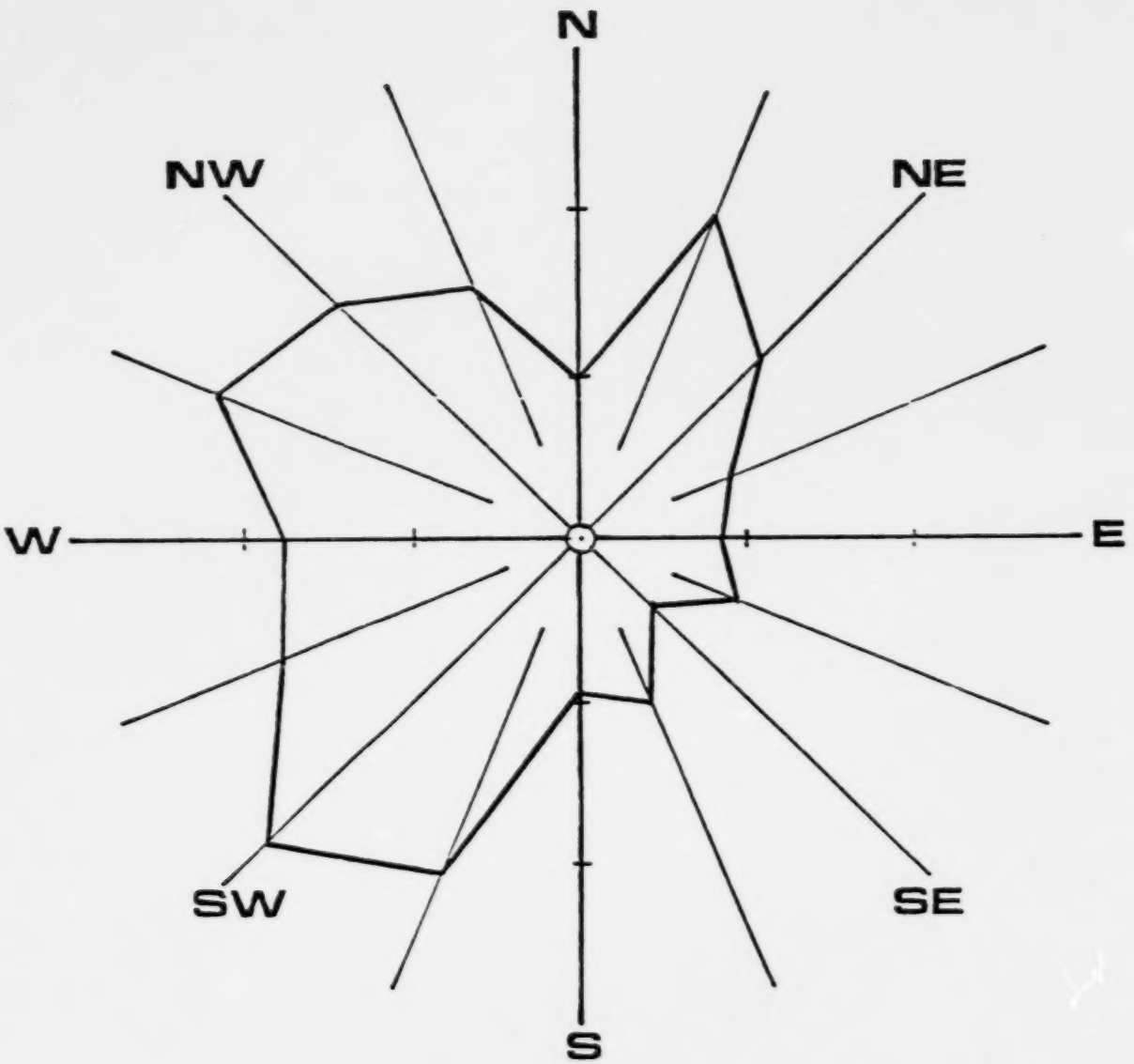

Figure 4-2. TEN YEAR AVERAGED ANNUAL WIND ROSE FOR NEWARK, NEW JERSEY

1955 - 1964. Scale: 1" = 4 percent, calm winds = 0.6 percent

Soil samples (10S, 11S) taken 150 meters east and west of the facility contained 4,250 ppb and 1,100 ppb of PBB, respectively. The prevailing downwind side (to the east) may be expected to contain the higher PBB concentrations if airborne emissions have occurred. The isomeric composition of the two soil samples (Table 4-2) show some differences. The higher concentration sample taken to the east of the plant consisted nearly exclusively of decabromobiphenyl (49 percent) and nonabromobiphenyl (47 percent) with traces of hexa-, hepta-, and octabromobiphenyl. The sample taken to the west of the plant contained larger relative amounts of hepta-and octabromobiphenyl and less nonabromobiphenyl. There is no readily available explanation for this significant difference in isomeric composition of the two samples.

A lichen was growing attached to rocks in a shallow, wet depression approximately 150 meters north of the facility. The lichen sample (22T) was rinsed with hexane and the hexane was concentrated and analyzed for PBB. The lichen contained surface deposits of 1,120 ppb based on the total dry weight. Hexa- through decabromobiphenyl isomers were detected on the lichen with nona- and decabromobiphenyl predominating much like the soils. This probably represents airborne deposition of particulate containing PBB.

Human hair (41H) taken from one Bayonne Beauty Salon contained 8.1 ppm of dibromobiphenyl in the extractable oil, which comprised 1.1 weight percent of the hair. This sample appeared to be of mixed male and female origin. Samples 39H and 40H taken from two other establishments

in the Bayonne area did not contain detectable levels of PBB. All three of these establishments cater to workers and residents in the area.

4.2 STANDARD T CHEMICAL COMPANY

The analytical results for samples taken in the vicinity of the Standard T Chemical Company facility on Staten Island are summarized in Table 4-4. Figure 1-1 shows the location of the facility approximately 3,400 meters west of White Chemical Corporation on the south bank of Kill van Kull. Figure 4-3 is a site diagram showing the collection point of the samples that were analyzed for PBB.

A 24-hour high-volume air sample taken 900 meters downwind of the facility on April 17, 1977 contained a trace (0.10 ng/m^3) of hexabromobiphenyl. A single, low velocity, exhaust stack exists at the plant with a height of approximately 13.5 meters above ground level. Emissions were not visible at the time of sampling. Prevailing winds in this region (Figure 4-2) are most frequently from the west. If airborne releases of PBB are common, soils in the vicinity may accumulate the material in surface layers.

As illustrated in Figure 4-3, soil PBB concentrations were highest at sample point 4S, which is located 700 meters east of the facility in the prevailing downwind direction. At this location, the soils contained 100 ppb of heptabromobiphenyl. Soils 900 meters west of the facility (2S) and 1,500 meters south (3S) each contained 10 ppb of hexabromobiphenyl alone, while the soil 75 meters to the southwest contained 30 ppb

Table 4-4. Analytical Results for Samples Taken in the Vicinity of Standard T Chemical Company, Staten Island, New York*

Sample Number	PBB ISOMER $C_{12}H_9Br$ 1	$C_{12}H_8Br_2$ 2	$C_{12}H_7Br_3$ 3	$C_{12}H_6Br_4$ 4	$C_{12}H_5Br_5$ 5	$C_{12}H_4Br_6$ 6	$C_{12}H_3Br_7$ 7	$C_{12}H_2Br_8$ 8	$C_{12}HBr_9$ 9	$C_{12}Br_{10}$ 10	Total†	Comments
1S	<10	<10	<10	<10	<10	10	10	<10	<10	10	30	Soil
2S	<10	<10	<10	<10	<10	10	<10	<10	<10	<10	10	Soil at Air Collection Site
3S	<10	<10	<10	<10	<10	10	<10	<10	<10	<10	10	Soil
4S	<10	<10	<10	<10	100	<10	<10	<10	<10	<10	100	Soil
5W	--	--	--	--	--	<.2	<.2	<.2	<.2	<.2	<.2	Receiving Water Discharge
6A	<.05	<.05	<.05	<.05	<.05	.10	<0.5	<0.5	<0.5	<0.5	.10	Downwind Air
7SE	<10	<10	<10	<10	<10	40	20	<10	<10	<10	60	Sediment at Discharge Site
8T	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	Algae in Kill van Kull
9T	--	--	--	--	--	230	<10	<10	<10	<10	230	Fish at Discharge Site
36H	<100	<100	<100	<100	<100	660	890	1,100	3,600	20,000	26,000	Male Hair Reported as ppb in oil residue
37H	<100	<100	<100	<100	<100	440	<100	<100	<100	<100	440	Female Hair Reported as ppb in oil residue
38H	<100	<100	<100	<100	<100	740	<100	<100	<100	<100	740	Male & Female Hair Reported as ppb in oil

* All data is reported as parts per billion (ppb) or ug/l, except for the air sample 6A which is reported as nanograms per cubic meter of air. Soil and tissue samples as reported on a dry weight basis.

† Sum of detected isomers in parts per billion (ppb) or ug/l, except the air sample which is reported as ng/m^3.

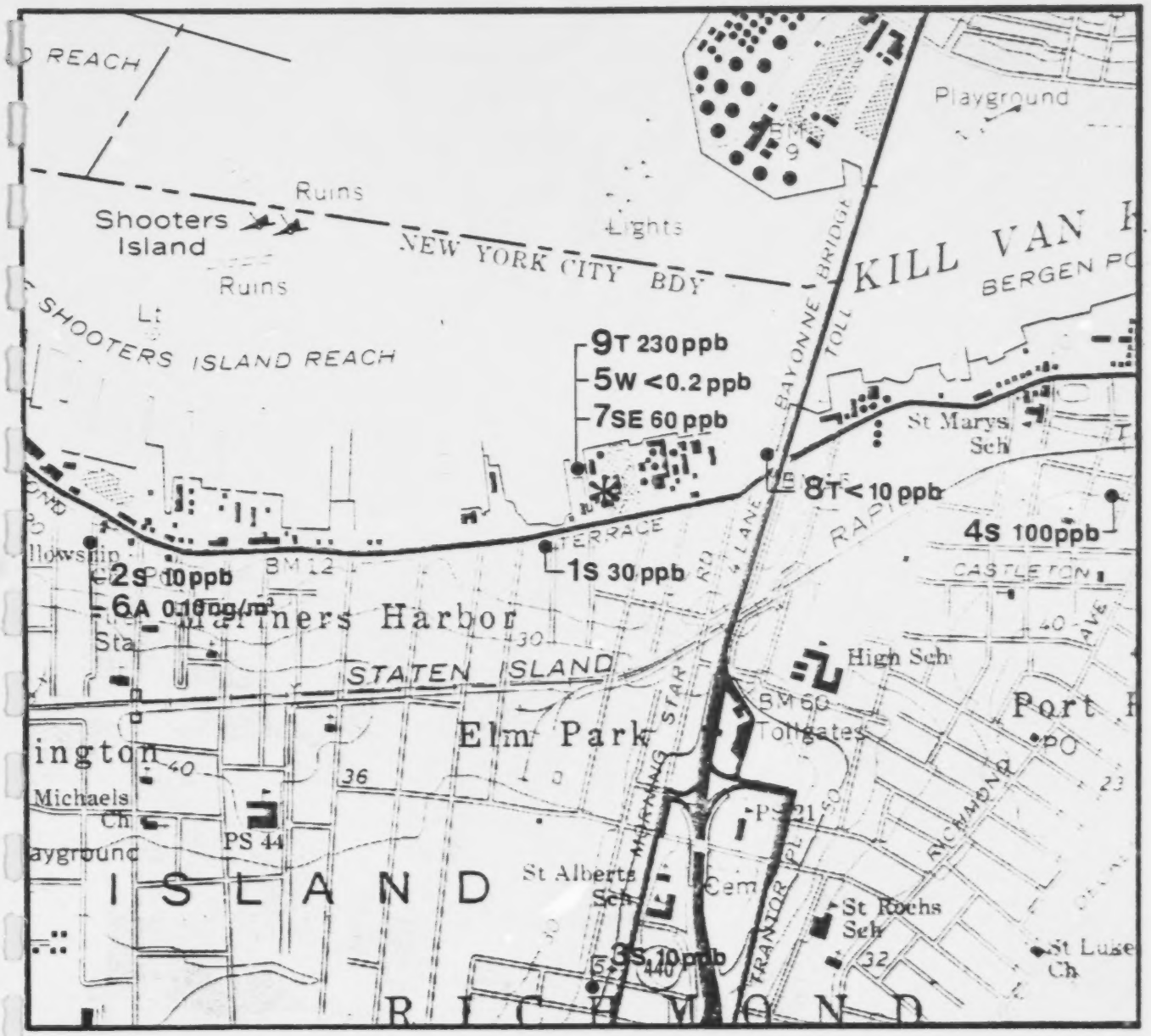

Figure 4-3. VICINITY OF STANDARD T CHEMICAL COMPANY, STATEN ISLAND, NEW YORK

* PLANT SITE

N

1 cm = 120 meters

total PBB, consisting of hexa-, hepta-, and decabromobiphenyl. There is some indication, therefore, of higher levels of soil contamination on the prevailing downwind side of the facility. However, there is no correlation between the isomer detected in the air sample (hexabromobiphenyl) at the time of sampling and that detected in downwind soils (heptabromobiphenyl).

The Standard T Chemical Company facility is located on a bulkheaded area projecting into Kill van Kull (Figure 4-3). Immediately to the west of the building is a 180-meter long finger canal. At low tide, this canal is nearly dry; at high tide water is present at a depth of 0.9 meters to 1.2 meters. One 10 cm diameter outfall into this finger canal appeared to originate at the Standard T facility. There was no discharge at the time of sampling.

A sample of the water (5W) in the finger canal at high tide did not contain detectable levels of PBB. Bottom sediments near the outfall (7SE) contained 40 ppb of hexabromobiphenyl and 20 ppb of heptabromobiphenyl. Killifish taken within the canal contained 230 ppb hexabromobiphenyl alone. Algae from Kill van Kull (8T) just to the east of the discharge point did not contain detectable levels of PBB.

A sample of male human hair (36H) taken from a barbershop on Richmond Avenue, Staten Island contained 26 ppm of PBB in the extracted oils. The oil content was 1.6 percent of the total sample weight.

Decabromobiphenyl comprised 77 percent of the PBB detected, nonabromobiphenyl 14 percent, and 2 to 4 percent each of octa-, hepta-, and hexabromobiphenyl. This barbershop is frequented by residents employed in the area. Samples of female hair (37H) taken from a beauty salon on Richmond Avenue contained 440 ppb of hexabromobiphenyl only, based on oil content. A sample (38H) taken at a second barbershop on Richmond Avenue, contained 740 ppb of hexabromobiphenyl.

4.3 HEXCEL FINE ORGANICS DIVISION

The Hexcel Fine Organics Division facility is located on Main Street east of Sayreville, New Jersey (see Figure 1-1). Table 4-5 summarizes the analytical results of samples taken from the surrounding area. Figure 4-4 is a site diagram from a topographic map showing the plant location and a swampy depression approximately 150 meters west of the plant. A roadside drainage ditch channels runoff waters from the elevated plant site and the road to the swamp. A 5 cm diameter outfall into the drainage ditch appeared to originate at Hexcel. There was no discharge from this outfall at the time of sampling; however, there was a standing pool of water in the eroded basin created by discharge from the outfall. A clear stream flows just to the south of the property and through a larger swampy area to the south.

A sample of the water standing in the roadside ditch immediately beneath the Hexcel outfall (30W) did not contain detectable PBB. However, a soil sample taken at that point (26S) contained 3.4 ppm of PBB. The percent composition of this and other samples taken in this area are

Table 4-5. Analytical Results for Samples Taken in the Vicinity of Hexcel Fine Organics, Sayreville, New Jersey*

Sample Number	PBB ISOMER $C_{12}H_9Br$ 1	$C_{12}H_8Br_2$ 2	$C_{12}H_7Br_3$ 3	$C_{12}H_6Br_4$ 4	$C_{12}H_5Br_5$ 5	$C_{12}H_4Br_6$ 6	$C_{12}H_3Br_7$ 7	$C_{12}H_2Br_8$ 8	$C_{12}HBr_9$ 9	$C_{12}Br_{10}$ 10	Total†	Comments
24S	<10	<10	<10	<10	<10	40	<10	<10	<10	<10	40	Soil
25S	<10	<10	<10	<10	<10	30	<10	<10	80	4,500	4,600	Marsh Soil
26S	<10	<10	<10	<10	<10	90	90	170	440	2,600	3,400	Soil in Roadside Ditch
27W	<.2	<.2	<.2	<.2	<.2	6.8	2.3	1.5	1.5	126	138	Water from Storm Sewer
28W	<.2	<.2	<.2	<.2	<.2	.2	.3	1.7	5.4	200	210	Water in Receiving Swamp Near Manhole
29W	--	--	--	--	--	<.2	<.2	<.2	<.2	<.2	<.2	Water from Artesian Well
30W	--	--	--	--	--	<.2	<.2	<.2	<.2	<.2	<.2	Water from Drainage Ditch
31W	--	--	--	--	--	<.2	<.2	<.2	<.2	<.2	<.2	Water from Receiving Swamp
32A	--	--	--	--	--	<.05	<.05	<.05	<.05	<.05	<.05	Downwind Air
33T	<10	<10	<10	<10	<10	<10	<10	140	4,500	87,000	92,000	Reeds in Receiving Swamp
34T	<10	<10	<10	<10	<10	10	10	<10	3,000	34,500	38,000	Reeds at Outfall
35T	--	--	--	--	--	20	<10	<10	<10	<10	20	Turtle
42H	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	Female Hair Reported as ppb in Oil
43H	<100	<100	<100	<100	<100	480	<100	<100	22,500	285,000	310,000	Male Hair Reported as ppb in Oil

Table 4-5. Analytical Results for Samples Taken in the Vicinity of Hexcel Fine Organics, Sayreville, New Jersey* (cont'd)

Sample Number	PBB ISOMER $C_{12}H_9Br$ 1	$C_{12}H_8Br_2$ 2	$C_{12}H_7Br_3$ 3	$C_{12}H_6Br_4$ 4	$C_{12}H_5Br_5$ 5	$C_{12}H_4Br_6$ 6	$C_{12}H_3Br_7$ 7	$C_{12}H_2Br_8$ 8	$C_{12}HBr_9$ 9	$C_{12}Br_{10}$ 10	Total†	Comments
44H	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	Male Hair Reported as ppb in Oil

* All data reported as parts per billion (ppb) or ug/l, except for air sample 32A which is reported as nanograms per cubic meter of air. Soil and tissue samples are reported on a dry weight basis.

† Sum of the detected isomers in parts per billion (ppb) or ug/l, except the air sample which is reported in ng/m^3.

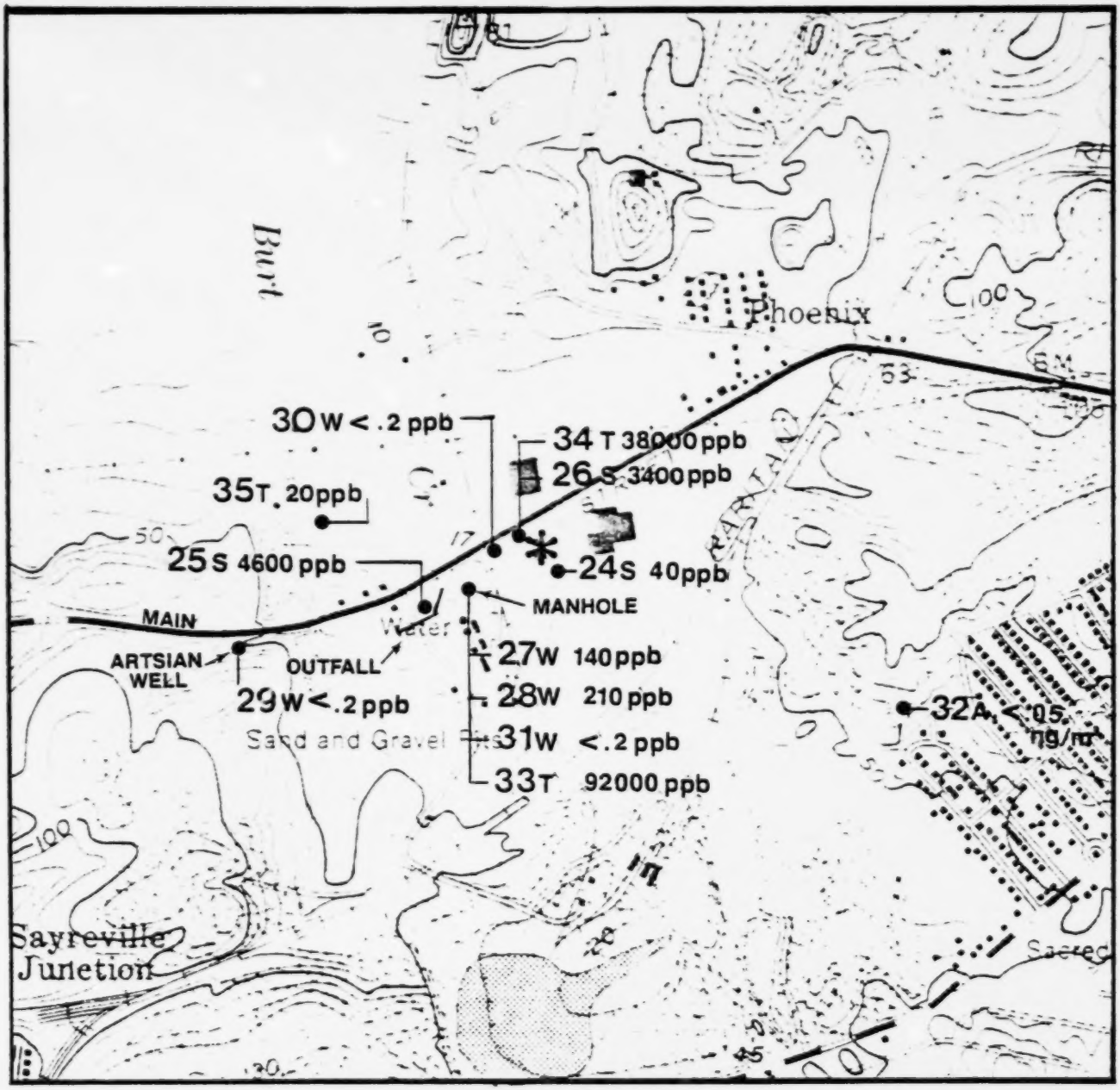

Figure 4-4. VICINITY OF HEXCEL FINE ORGANICS, SAYREVILLE, NEW JERSEY

* PLANT SITE

summarized in Table 4-6. The PBB was 77 percent decabromobiphenyl, 13 percent nonabromobiphenyl, 5 percent octabromobiphenyl, and lesser quantities of hexa- and heptabromobiphenyl. Reeds growing immediately adjacent to the outfall (34T) contained a surface accumulated concentration of 38 mg PBB per kilogram of dried tissue in the form of predominantly (92 percent) decabromobiphenyl and some (8 percent) nonabromobiphenyl. These data seem to indicate that PBBs have been discharged at this location in the past.

A storm sewer manhole access is located within the swamp west of the facility described above. The swamp receives any flow from the roadside drainage ditch and the Hexcel outfall. The access is located approximately 15 meters from the edge of the swamp. The access cover was approximately one-half meter above the level of the water in the swamp, but the cover was broken around the top. During the morning, extremely noxious fumes, (an odor similar to chloroform) emanated from the manhole access. A sample of the swamp water adjacent to the manhole (28W) contained 210 ug/l PBB, consisting of predominately decabromobiphenyl with uniformly lesser amounts of lower-substituted isomers to hexabromobiphenyl. A sample of water taken from the storm sewer (27W) through the manhole access contained 138 ug/l PBB with decabromobiphenyl predominant (Table 4-6). Reeds from the same location (33T) contained accumulations of 92 mg/kg decabromobiphenyl and nonabromobiphenyl with traces of octabromobiphenyl. The presence of decabromobiphenyl in this sample was confirmed by full spectrum GC/MS. A water sample taken near the west edge of the swamp (31W) did not contain detectable levels of

Table 4-6. Percent Composition of PBB Detected in Samples Taken in the Vicinity of Hexcel Fine Organics Division

	PBB ISOMER					
Sample	$C_{12}H_4Br_6$	$C_{12}H_3Br_7$	$C_{12}H_2Br_8$	$C_{12}HBr_9$	$C_{12}Br_{10}$	Description
25S	<1	0	0	2	98	Marsh Soil
26S	2.5	2.5	5	13	77	Soil in Roadside Ditch
27W	5	1.6	1	1	91	Water from Storm Sewer
28W	<1	<1	1	2.6	96	Water in Receiving Swamp Near Manhole
33T	0	0	<1	5	95	Reeds in Receiving Swamp
34T	0	0	0	8	92	Reeds at Outfall
43H	<1	0	0	7	92	Male Human Hair Oil

PBB, however, a marsh soil sample (25S) contained 4.6 ppm of PBB, almost all of which was decabromobiphenyl. More detailed GC/MS analysis of the water taken from the swamp adjacent to the manhole access (28W), resulted in the identification of both PBBs and polybrominated diphenyl ethers as listed in Table 4-7.

Apparently PBBs have entered the swamp by drainage from the outfall into the roadside ditch. Furthermore, PBB-containing wastewaters are present in the storm sewer. Waters from this swamp overflow through two concrete pipes, under a dirt road, into a pond, and eventually into the Raritan River through Burt Creek. The discharge from the swamp was approximately 2,720 l/min (720 gpm) at the time of sampling. A snapping turtle taken from Burt Creek contained a tissue concentration of 20 ppb hexabromobiphenyl.

A soil sample taken 75 meters southeast of the Hexcel facility (24S) contained 40 ppb of hexabromobiphenyl. An air sample taken downwind of the plant did not contain PBB.

A free-flowing artesian well frequently used by local people for potable water is located approximately 1,000 meters to the west of the Hexcel facility. Analysis of the artesian well water failed to detect any PBB.

Human hair samples were taken from a barbershop and a beauty salon at a shopping center and from a barbershop near Sayreville. One barbershop sample contained detectable levels of PBB. This sample contained PBB at a

Table 4-7. Brominated Compounds Detected in Waters Taken From Swamp Near Main Street in Sayreville, GC/MS Analysis

$C_{12}H_4Br_6O$
$C_{12}H_3Br_7O$
$C_{12}HBr_9O$
$C_{12}HBr_9$
$C_{12}Br_{10}$
$C_{12}Br_{10}O$

[a]The bromobiphenyls were confirmed by comparison of mass spectra and retention times with authentic standards.

[b]GC conditions: 2% OV-101 coated on Gas-Chrom Q; column: 45 cm x 0.2 cm i.d., 20 cc/min helium, 100° initial, programmed at 12°/min to 300°.

level of 310 ppm in the oil residue which constitutes 1.1 percent of the total weight of the sample. The PBB consisted of 92 percent decabromobiphenyl, 7 percent nonabromobiphenyl, and 1 percent hexabromobiphenyl. It is estimated that approximately half of this sample was from adult white males and the other half from juvenile white males. The female hair sample taken from the nearby beauty salon was free of PBB. The male hair sample from the third shop was also free of PBB.

5.0 REFERENCES

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APPENDIX A

LIST OF SAMPLES COLLECTED

White Chemical Company

Sample Type	Location Relative to Plant in Meters		Amount	Comments
Air	1500	North	24 Hrs.	Crosswind 5-13mph
	1500	South	24 Hrs.	Crosswind 5-15mph
	1500	West	24 Hrs.	Upwind 5-15mph
	1500	North	24 Hrs.	Downwind 5mph
	1500	North	18 Hrs.	Downwind 5mph
	1500	North	18 Hrs.	Downwind 5mph
Soil	750	West	1 Kg.	No rain or problem weather during sampling.
	750	North	1 Kg.	
	150	West	1 Kg.	
	150	East	1 Kg.	
	150	West	1 Kg.	
	300	South	1 Kg.	
	1500	West	1 Kg.	
	375	West	1 Kg.	
	375	West	1 Kg.	
	1500	North	1 Kg.	
	1500	East	1 Kg.	
	1500	South	1 Kg.	
	750	North	1 Kg.	
Receiving Waters	<20	East	4 liters at top samples 1 liter for middle and bottom	Top, middle, and bottom sample taken at all sites.
	<20	In front		
	<20	West		
	100	East		
	100	In front		
	100	West		
	500	East		
	500	In front		
	500	West		
	100	In Platti Kill		
	500	In Platti Kill		
	Head of Platti Kill		1 liter	5 samples were taken here at various depths and locations.
	100	West on dock	1 liter	Kill van Kull
	200	West on canal	1 liter	
	200	West on canal	1 liter	
Sediments	One sediment was taken at each water sampling site for a total of nine sediments in the Kill van Kull. 1 Kg. of sample was obtained.			

White Chemical Company (continued)

Sample Type	Location Relative to Plant in Meters		Amount	Comments
Sediments	Head of Platti Kill		1 Kg.	
	100	West on Dock	1 Kg.	Kill van Kull
	500	East	1 Kg.	Platti Kill
Biota	100	West on dock	100 g.	Algae
	20	North	100 g.	Lichen
	200	Northeast	100 g.	Algae
	200	West on canal	100 g.	Fish
	Several samples of fish were taken by trap in the canal 200 meters from the plant. These were resident fish and will be divided into species before analysis.			
Standing Water	300	North	1 liter	Puddles in reeds
	200	Northeast	1 liter	
	400	Northwest	1 liter	Near apts.
	60	South	1 liter	
	200	West	1 liter	Sewage outfall
	100	Northeast	1 liter	Oil skim pond
	100	Northeast	1 liter	Oil skim pond
Wastewater	200	West	1 liter	Steam line
	100	West	1 liter	Outfall
	100	West	1 liter	Sewage outfall
	100	Northeast	1 liter	Oil skim pond outfall
	100	Northeast	1 liter	Oil skim pond
Polyurethane Foam (PUF)	100	Northeast		Oil skim pond
	100	Northeast		Oil skim pond
	100	Northeast		Oil skim pond
	100	Northeast		Oil skim pond
	Head of Platti Kill			Oil skim
	Head of Platti Kill			Oil skim
Hair	3 hair samples were taken from both men's and women's shops.			

Table 2. Standard T Chemical Company

Sample Type	Location Relative to Plant in Meters		Amount	Comments
Air	900	West	24 Hr.	Downwind 15-20 mph
Soil	75	Southwest	1 Kg.	No change in weather while sampling.
	75	Southeast	1 Kg.	
	900	West	1 Kg.	
	900	West	1 Kg.	
	750	South	1 Kg.	
	750	East	1 Kg.	
	1500	East	1 Kg.	
	1500	South	1 Kg.	
	1500	West	1 Kg.	
Receiving Water	<20	East	Top is 4 liters bottom and middle are 1 liter.	All locations include surface middle and bottom samples.
	<20	North		
	<20	West		
	100	North		
	100	East		
	500	East		
	500	North		
	500	West		
	<10	West	1 liter	Canal beside plant
	<10	West	1 liter	
	<10	West	1 liter	
	<10	West	1 liter	
	400	East	1 liter	Concrete plant
Sediments	Sediments were taken at each water site		1 Kg.	
	<10	West	1 Kg.	Canal by plant
	400	East	1 Kg.	Concrete plant
	400	South	1 Kg.	RR Bridge
Standing Water	1500	West	1 liter	Drainage ditch
	1500	East	1 liter	Drainage ditch
Biota	<10	West	100 g	Canal by plant
	400	West	100 g	Algae
	400	West	400 g	Rodent
	500	West	1000 g	Cat
	<10	West	Several types of fish and marine species were seined.	
Hair	3 hair samples were taken from both men's and women's shops.			

Table 3. HEXCEL FINE ORGANICS

Sample Type	Location Relative To Plant in Meters		Amount	Comments
Air	750	North	6 Hour	Upwind - 10mph
	1500	South	12 Hour	Crosswind - 10mph
	1500	East	15 Hour	Downwind - 10mph
	1500	West	15 Hour	Upwind - 10mph
	750	Southeast	6 Hour	Downwind - 10mph
	750	Southeast	18 Hour	Downwind - 10mph
	750	Southeast	6 Hour	Downwind - 10mph
	750	Southeast	18 Hour	Downwind - 10mph
Soil	150	East	1 Kg.	No weather
	750	East	1 Kg.	change during
	1500	East	1 Kg.	sampling period.
	300	West	1 Kg.	
	750	West	1 Kg.	
	1500	West	1 Kg.	
	150	North	1 Kg.	
	750	North	1 Kg.	
	1200	North	1 Kg.	
	750	North	1 Kg.	
	750	South	1 Kg.	
	1500	South	1 Kg.	
	7500	Southeast	1 Kg.	
	80	West	1 Kg.	Road Bed
Waters	100	West	1 Liter	Pond
	200	Southwest	1 Liter	Swamp
	100	West	1 Liter	Drainage Ditch
	200	Southwest	1 Liter	Outfall to Pond
	50	North	1 Liter	Storm Sewer
	1200	North	1 Liter	Toward Raritan
	400	North	1 Liter	Toward Raritan
	75	West	1 Liter	Around manhole
	750	South	1 Liter	JFK Park
	750	South	1 Liter	JFK Park
	400	Southeast	1 Liter	
	75	West	1 Liter	From manhole
	20	East	1 Liter	Possibly Essex Co.
	20	Southeast	1 Liter	Runoff
	750	West	1 Liter	From artesian well
Sediments	100	West	1 Kg.	Pond
	100	West	1 Kg.	Swamp
	200	West	1 Kg.	Outfall at Pond

HEXCEL FINE ORGANICS (continued)

Sample Type	Location Relative To Plant in Meters		Amount	Comments
Biota	50	West	100 g	Swamp
	100	North	100 g	Algae
	400	Northeast	100 g	Vegetation
	500	Southeast	1000 g	Tadpoles
	500	Southeast	1000 g	Fish
	500	Northwest	100000 g	Turtle
Polyurethane Foam (PUF)	50	West		Swamp
	400	North		Stream
Hair	Samples obtained from a shop in Sayreville			